ON THE INFLUENCE

OF

ANCHOR ICE

IN

Relation to Fish Offal

AND THE

NEWFOUNDLAND FISHERIES:

By HENRY Y. HIND.

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PART II.

Contents.

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PART II.

I. THE RELATIVE QUANTITY OF OXYGEN REQUIRED BY FISHES, OLD AND YOUNG.

ASSUMING that the analysis of the gases contained in sea water, by Mr. Lant Carpenter* represents their average quantities and composition in the Atlantic Ocean, under circumstances which permit of perfect æration, we have the means for obtaining a correct view of the relative consump-

*Appendix A. in Sir Wyville's Thomson's "Depths of the Sea."—Summary of results of the examination of samples of sea water taken at the surface and at various depths. By William Lant Carpenter, B.A., B. Sc. p. 502.

tion of oxygen by marine life, and the sources of the unfailing supply of the life-sustaining gas.

Different species of fish of the same weight require about the same quantities of oxygen to support respiration, but of the same species, the older individuals require much less than the younger in proportion to their weight. A cod-fish of 20lbs. weight requires very much less oxygen than the same weight of young fish, and the quantity required by the individual young is out of all proportion to the quantity required by old fish. This curious and important fact arises from the respiratory process being much more active in young fish than in old individuals, and its discovery and announcement, together with other important discoveries in relation to fish life, are due to M. Quinquand, who some time since brought the subject before the Academy of Sciences in Paris.

M. Quinquand has also ascertained the relation which exists between fishes and man, as to quantity of oxygen consumed in respiration. We are thus better able to comprehend the great value of thoroughly ærated waters to young fish, and the character of the deleterious effects likely to be produced by fish offal, and indeed any substance which upon decomposition consumes the oxygen of sea,—or river water —necessary for the respiration of very young and small fishes, such as sawdust from mills, or vegetable or animal refuse of any kind.

We can also comprehend the vast importance of winds and currents in ærating the ocean, and of a rapid flow in rivers in ærating their waters.

According to Mr. Lant Carpenter, the surface water of the ocean contains a greater quantity of oxygen and a less quantity of carbonic acid after a strong wind.

In order to show that young and small fish, whose respiration is very active, consume considerably more oxygen than old or large fish in proportion to their weight, the

illustrations supplied by M. Quinquand may be instanced.

Comparing the respiratory requirements of the perch with those of man as a standard, we have the following suggestive proportions;

A perch weighing over one pound has a respiratory activity *one-ninth* as great as a man in proportion to its weight. A perch weighing one third of a pound consumes *two-ninths* as much oxygen as a man. A young perch not one-sixteenth of a pound in weight consumes *one-half* as much oxygen as a man in proportion to weight of living matter.

Applying these relative quantities to the codfish, the relation stands as below :—

A number of codfish each weighing 3lbs., and together equal in weight to a full-grown man, consume, say, only one twentieth as much oxygen in respiration as the man. A larger number of smaller codfish of one pound each, but of the same aggregate weight as the man, consume one fifth as much oxygen; but a number of cod fry equal in aggregate weight to the man consume half as much oxygen. These remarkable differences in respiratory activity, and consequently in the demand for the supply of oxygen, show how important it is for fish fry and young fish to have an abundant and constant supply of the vital gas.

M. Quinquand has pointed out another and equally important fact connected with the respiratory process of young fish. The young of *air-breathing* animals resist asphyxia or suffocation by deprivation of oxygen, much more vigorously than adults, but the young of *fish* respiring by means of gills, seem to suffer much *more* rapidly than adults when the proper supply of oxygen diminishes. From these considerations it follows, that as young fish and fish fry visit during the summer the coastal and shoal waters, and are probably hatched in them, the fish offal is thrown into the sea at the precise spot where it is likely to be most prejudicial

to young fish life. It also follows that sea water which will support the life of fish, one, two and more pounds in weight, will destroy the life of young fry. Sculpins and flatfish, which abound near the stage heads in summer, may live and thrive in water wholly unfit for the respiration of young fish, which require abundance of oxygen. Hence on cod banks, and on all fishing grounds where fish offal is thrown overboard, large fish, and fish over one or two pounds weight *may not* be injured by it, yet small fish and fish fry, whose respiratory processes are entirely active, will be destroyed, especially during calms.

Marine life, *without red blood corpuscules*, and of lower respiratory organization than young fish, will not be injured by water deprived of oxygen by decomposing fish offal, to an extent sufficient to destroy young fish life. In brief, all of M. Quinquand's experiments and observations point to the positive necessity for preserving in a state of purity those waters in which fish spawn is hatched, and in which young fish disport themselves.

Valuable information on the necessity for a continuous supply of oxygen for young fish is to be found in the "Report on the Progress of Pisciculture in Russia," given at page 493 of Commissioner Baird's Report for 1872 and 1873. M. Theodore Soudakevicz states in this report, that "if the water contains less oxygen than is required to oxidize the blood, the gills change their lamellæ, and their fringes agglutinate, decompose, are covered with parasites, and the want of oxygen necessarily brings about the death of the fish."

II. THE SOURCE OF THE FOOD OF THE COD

IN the "Notes on the Northern Labrador Fishing Grounds" I have briefly referred to the unfailing supply of Arctic food, brought down by ice and accumulated on the continuous range of Banks which extend from Cape Aillik to Cape Chudleigh.

It may be well to describe with some detail the character of the Arctic waters as food producers, for it is a popular impression that the cold of the Arctic Seas is prejudicial to life. In truth the Arctic waters and the great currents flowing from them, are in many places a living mass, a vast ocean of living slime, and the all-pervading life which exists there affords the true solution of the problem which has so often presented itself to those engaged in the Great Fisheries, where the food comes from which gives sustenance to the countless millions of fish which swarm on the Labrador, on the coast of Newfoundland, and in Dominion and United States' waters, or wherever the Arctic Current exerts an active influence.

Professor Nordenskiöld reminds us, in an account of "an Expedition to Greenland in 1870," that Hudson and other veteran mariners of the Arctic Seas mention the variety of colours characterizing the water in certain parts of the Polar Sea, which are frequently so sharply distinguished that a ship may sail with one side in blue water, and the other in greyish-green water.

It was at first supposed that those colours were indicative of different currents—the green of the Arctic and the blue of the Gulf-stream. Later, Scoresby affirmed that the phenomena arose from the presence of innumerable organisms in the water. Subsequently Dr. Brown, during a voyage

made by him as surgeon in a whaler, continued the observations, and more recently Professor Nordenskiöld himself.

The sea water in the neighbourhood of Spitzbergen he describes as marked by two sharply distinguished colours, greenish grey and fine indigo-blue,

In the Greenland Seas there is water with a very decided tinge of brown. The grey-green water is generally met with *in the neighbourhood of ice;* the blue where the water is free from ice; the brown, as far as Professor Nordenskiöld's observations go, chiefly in that part of Davis' Straits which is situated in front of "Fiskernaes" (Lat. 63° 1', Long. 50° 1') on the Greenland coast opposite the mouth of Hudson's Straits.

When specimens of the water are taken up in an uncoloured glass, it appears perfectly clear and colourless, nor can the unassisted eye discover any organisms to account for the colour. But if a fine insect-net be towed behind the ship, it will soon become covered with a film of green in the green water, and with a film of brown in the brown water. These films are of organic origin. It is a living slime, and where it abounds there are also to be found swarms of minute crustaceans which feed on the slime, and in their turn become the food of larger animals.

Dr. Brown shows that the presence of this slime spread over a hundred thousand square miles, is a condition necessary for the subsistence, not only of the swarms of birds that frequent the Northern Seas, but of the large marine animals, even up to the giant whale.

In Southern Seas the "slime of the ocean" is equally abundant. On the 4th February, 1874, in lat. 52.29 south, long. 71.36 east, Sir Wyville Thomson found this "slime" a little to the north of the Heard Islands. The tow net which was dragging a few fathoms below the surface, came up nearly filled with a pale yellow gelatinous mass, which

was found to consist entirely of Diatoms, and of the same species as were found at the bottom. Sir Wyville Thomson expresses surprise that the diatoms on the surface did not appear to be in large numbers over what he has termed the diatom ooze, as in some other localities, where he found them near the surface and beyond or south of the diatom ooze belt; but he explains their apparent absence by stating that "this may perhaps be accounted for by our not having struck their *belt of depth* with the tow-net, or it is possible, &c."* The "belt of depth" at which these minute but infinitely numerous organisms live appears to vary with changes in the pressure of the atmosphere and the temperature. But the myriads of minute crustaceans which feed on the "slime" rise and fall with it. Now they may be at the surface, in an hour a fathom below, and in a day the zone of life may be five fathoms below the surface, and with it the minute crustaceans and the hosts of other marine animals which prey on these. Hence it is that the "herring bait," the "mackerel bait," the "red," "yellow" and "black herring meat" of the Norwegian fishermen, are found at variable depths, following their food, and thus leading the herring to different zones below the surface of the ocean, all of which may be comprised within a score of fathoms. These facts are the key to mysteries which have hitherto shrouded the movements of the herring. But this "slime of the ocean" appears to live most abundantly in the coldest water and in the neighbourhood of ice. How is it, then, brought on to the Labrador in such an unfailing stream as indirectly to afford an endless supply of food to the cod on the Labrador banks? The answer to this question leads at once to a brief description of the ice drift.

* "NATURE," December 10th, 1874.

III. THE ICE DRIFT.

THIS is one of the grandest phenomena on the face of the globe. It is so vast, so uniform and so unceasing, that, with the exception of the Gulf-stream, from its initiation to its close, nothing on earth can compare with it.

Coming from the Spitzbergen Seas, and hugging the coast of East Greenland, the Polar ice-ladened current creeps south-westerly past Iceland, past Greenland, and the known east coast, towards Cape Farewell. Its rate of progression is about four miles a-day, the breadth of the ice-burdened stream about 200 miles. After Cape Farewell, the most southern part of Greenland is reached, the grand procession of ice-bergs and ice-floes turns slowly to the west, then in a wide curve to the north-west and towards Davis' Straits. Augmented by additions from Western Greenland coming down Baffins Bay, the mighty stream begins to turn to the westward in the life-teeming seas off Fiskernæs, and approaches Frobisher Bay, and Hudson's Straits. Here it receives fresh accessions of bergs and floes, the united armies trending southerly, then south-easterly towards the Labrador, and on the banks off this coast countless thousands ground, bringing with them their "slime." Others drift on past the Newfoundland coast until they are lost in the Gulf-stream, but paving the bottom of the ocean with the skeletons of the Diatoms they have brought from the north. Recent high authority confirms the view of this course of the northern ice stream advanced some years since by Colding, and others. Admiral E. Irminger, of the Danish Navy, in a recent paper on "the Arctic Current around

Greenland* adopts the generally received conclusion that the current from the ocean around Spitzbergen which carries the icebergs and floes after it, has passed along the east coast of Greenland, turns westward and northward around Cape Farewell, *without detaching any branch* to the *south-westward directly towards the Banks of Newfoundland.* The current afterwards runs northward along the south-west coast of Greenland, until about latitude 64 degrees north, and at times even as far up as 67 degrees. Afterwards turning westward, it unites with the current coming from Baffin's and Hudson's Bays, running to the southward on the western side of Davis' Straits, along the coast of Labrador.†

It is thus that the "slime" which accompanies the icebergs and ice floes of the Arctic, accumulates on the Banks of Northern Labrador, and renders the existence possible there of all those forms of marine life,—from the diatom to the minute crustacean—from the minute crustacean to the prawn, starfish and crab, together with molluscous animals in vast profusion,—which contribute to the support of the great schools of cod which also find their home there.

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* Vide—A selection of papers on Arctic Geography and Ethnology, reprinted and presented to the Arctic Expedition of 1875, by the President, Council and Fellows of the Royal Geographical Society. —'NATURE,' June 10th, 1875.

† 'NATURE,' June 10th, 1875.

IV. FOOD OF THE COD IN NORTHERN SEAS.

DURING my visit to the Labrador last summer I was rather surprised to find that the Newfoundland fishermen appeared to place entire reliance upon four kinds of bait for cod, namely, the caplin, the squid, the herring and the launce. I gathered from conversation with many of them, that the opinion prevailed that the cod were nourished almost exclusively upon this food, and that where there were no caplin, &c., there would be no "fish," as the cod is popularly termed. It may therefore not be out of place to enumerate some of the opinions of prominent naturalists on this very important subject.

Sir Wyville Thomson tells us in that most instructive and interesting work "The depths of the Sea," that the Färoe Banks (lat. 61. long. 9°) are frequented during the fishing season by numerous English and Foreign fishing vessels, whose chief pursuit is the cod. These banks are about 160 miles north-west of Scotland. The cod abound on the banks and are chiefly of large size. The depth of water varies from 45 to 100 fathoms. "The banks swarm with the common brittle star *(ophiothrix fragilis)*, with the Norway lobster (*nephrops norvegicus*), large spider crabs, several species of the genus *galathea*, and many of the genus *crangon* (shrimp). So ample a supply of their favourite food *readily accounts* for *the abundance and excellence* of *the cod and ling on the Banks*." *

Passing the Davis' Straits and the coast of Greenland, Dr. Robert Brown states that "the invertebrata of Disco Bay

* "The Depths of the Sea," page 60.

lat. 69) are numerous, mollusca echiondermata, crustacea, polyzoa, nydrozoa, &c., abounding, though to nothing like the extent the lower forms of animal life swarm on the Riskoll cod-banks." *

Dr. Sutherland † states that the limits of the Riskoll Bank can be defined almost at all times by the clusters and roups of small icebergs that take ground upon it, and this ank "like other banks of a similar character but less xtensive on the same coast, is exceedingly fertile in schools f codfish and halibut which frequent it in the months of lay, June, July and August."

This description of the icebergs on the Riskoll cod bank pplies exactly to the banks off the coast of Northern Labrador, and the fact that the cod are so abundant there, opposite as it were to the Labrador, (the Torske Bank) during the months of May, June, July and August supplies a potent argument against an impression quite common among Newfoundland fishermen respecting the supposed extensive migrations of the schools of cod. Indeed cod of large size may be simultaneously caught on the Newfoundland coasts, the Labrador, the west side of Davis Straits, and the east side or Greenland coasts of the same Straits. Richardson in his '*Fauna Boreali Americana*,' page 243, quotes Davis' description of his run across the entrance of Hudson's Straits from latitude 67 degrees to 57 degrees on the Labrador coast as illustrating the abundance of the cod in those waters. Davis says "before the bait was changed we took more than forty great cods, the fish swimming so abundantly thick about our bark as is incredible to be reported."

* Geological Magazine—Feb., 1875.
† Proceedings of the Geological Society—London, 1853.

V. DISTRIBUTION OF FISH OVA BY THE ICE DRIFT.

IT will not escape notice that the same ice drift which brings the "slime" and the myriads of crustaceans must also carry with it minute codfish spawn. The never-failing stream of bergs and floes sailing so grandly past the numerous cod banks on the Greenland coast, and crossing with semi-circular sweep to the American side of Davis Straits and then to the Labrador, can scarcely fail to *convoy* innumerable cod ova, together with the original diatom source of the food of young fish, and of adults after multitudinous transformations.

Cod ova appears to find the *coldest surface water* most suitable for their development, for the spawn is shed during the coldest months of the year in those waters where ice does not prevail to ensure the requisite degree of coldness. On the coast of Nova Scotia in October.* On the well-known George's Bank off New England, in February and March.† In November and December in the Bay of Fundy.‡ Probably, however, the season of each local school is determined to a greater or less extent by the coldest mean temperature of the surface water near its *habitat*—a home, as long as new ice does not interfere. Every drop of surface sea water as it cools descends, and in the fall of the year the surface water is the warmest, the coldest stratum being at the bottom. This as is well known is not the case with fresh water, below a temperature of forty degrees.

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* Revd. T. Ambrose—"Some observations on the Fishing Grounds and Fish of St. Margaret's Bay," N. S. Trans. N. S. Inst. Nat. Sci. 1866.

† T. F. Whiteaves—Canadian Naturalist, Vol. VII.

‡ Ibid.

If records of the spawning periods throughout the entire area of the North American Cod Fisheries were collated, it would be found that this fish spawns all the year round. Where there is no great ice drift, such as has been described, to cool the surface water in summer, the periods of shedding and hatching of spawn are adjusted to accommodate themselves to the temperature of the coastal waters, or the temperature of banks and shoals.

The coasts of Nova Scotia swarm with cod fry in the fall at the period when ice has formed, and is forming, on the Labrador and parts of the Newfoundland Coast, and it must be borne in mind that there is a wide distinction between the spawning of inshore cod and bank cod.

With regard to fresh water fish eggs and embryo it appears that within certain limits "the higher the temperature of the water in which eggs are placed the more rapidly the embryo fish develops within the egg and the sooner it escapes from its enclosure in the shell." (Milner—U. S. Fishing reports, Spencer F. Baird, Commissioner.)

The observations of Sars have shown, as already stated, that codfish spawn floats during the greater part, if not the whole of the period of its development, but we do not know the duration of that period in different waters and climates. We are quite justified in supposing that ova may be shed and hatched throughout the entire length and period of the Great Ice Drift, the ova being derived from schools of fish which haunt the banks and shoals past which the drift is for ever stealing. We know too, that the young fish would be hatched during the short summer in a sea of food most suitable for them, and in this beautiful compensating arrangement we can discern provision for a continuous supply—literally a stream—of ova and young fish, drifting towards our coast to assist in replacing the three hundred million fish which are annually taken from North American waters by fishermen of all nations. This living but disjointed stream of life, like links in a chain, which accompanies the icebergs, assists too

in replacing the countless thousands of young fry which are poisoned by the fish offal in the coastal waters. But there is a danger in store for the ova which may thus drift on to Newfoundland shores, and also for the ova of local schools of fish. The winter months being the period during which many schools spawn, this time may also be the season on parts of the Newfoundland Coast, or rather adjacent to it, and much of the spawn may be taken under the fringe of coast ice by tidal currents. In favourable situations the process of development goes on uninterruptedly, but according to the observations of Dr. Ranson,* oxygen is necessary for the development of the ovum, and if oxygen be absent from the water in which the ova are suspended, death ensues. This condition, as already shown, exists over wide areas beneath the ice in the neighbourhood of fish stages. The offal consumes the oxygen by its slow decomposition, and it cannot be replaced under the icy covering, until the ice breaks up in the spring or during storms, but meanwhile life in the ovum is destroyed.

According to the views here presented, some of the ova supplied by the cod shoals whose *habitat* is the Forske Bank, off Sukkertoppen, and banks lying south of those celebrated cod grounds on the coast of Greenland, floats with the ice-ladened stream towards Cumberland Sound and Frobisher Bay, and is hatched on its journey, the young fish fry finding a new home in mid ocean or on the western coast of Davis Straits. Some of the ova from the schools described by Davis on that coast, floats with the ice stream in the track Davis followed towards the Labrador, and is hatched, it may be, near Cape Chudleigh. Some of the ova from the Cape Chudleigh schools,—and these are numerous,—float with the iceberg stream along the coast of Labrador and are hatched on the Southern Labrador. Southern Labrador fish supply ova which is carried by the same unfailing ice stream partly into the Gulf and partly along the north-east coast of New-

* W. H. Ranson, M.D.—*Vide* Journal of Anatomy and Physiology, Vol. I.

foundland towards the Grand Banks, and so on, as far as the icebergs travel, and cool the surface water sufficiently to admit of the proper development of the ova. It may be that this drift of spawn supplies an explanation of a statement made to me last summer that the codfish about Cape Chudleigh are largely nourished during the short summer season by feeding upon the young of their own species. One would suppose, that if no other source of young cod existed there but the supply naturally furnished by local schools, the result would ultimately be extermination, notwithstanding the wonderful fecundity of the cod. The observation, if correct, suggests the use of young cod as bait in seas where bait to which the fishermen are accustomed, is supposed to be difficult to procure. But the questions involved in the term 'bait' are too numerous and comprehensive to be adverted to here, and it will suffice to say that what is 'bait' in one season is not bait in the fisherman's acceptation of the term in another season. A codfish would turn from a squid in May or October, which he would seize with avidity in July, and the shell fish which form a considerable portion of his food, and which are used as bait in Europe, do not appear to have attracted attention here.

The conclusions which flow from the foregoing brief exposition of certain ice phenomena on the coasts of Labrador and Newfoundland in relation to the fisheries, appear to justify the opinion that although considerable apparent diminution has taken place during late years in the yield of the shore fisheries, there is no ground for the supposition that the fisheries generally are failing, or that the resources of the seas which wash these shores have been taxed beyond their powers of production, or that by judicious caution, easily exercised, the inshore fisheries may not become as prolific as formerly. The means for reproduction are on a scale so grand and inexhaustible, the fields from which supplies are drawn to nourish the schools of fish are so vast in their extent and so far beyond the power of man to injure or diminish, that the *one care* appears to be thrown upon him, to protect from useless destruction that which is

incessantly brought within his reach. The Northern Labrador fishing grounds offer a new and wide field for industry, with resources and advantages far greater than have hitherto been ascribed to them.

Their occupation will afford time for the recuperation of other fields nearer home, which require *rest* after yielding their treasures abundantly for generations, and at the same time, *protection* from indiscreet and unnecessary pollution, which in the long run of years has greatly aided in diminishing their fertility.

HENRY Y. HIND.